CONSERVATION PROGRAMMES OF TWO STRAINS OF IBERIAN PIGS

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SUMMARY

The results of two conservations programmes focused to preserve genetic ressources of populations of Iberian pigs isolated since the year 1944 are presented. The consequences of changes in family structure and mating plans in the evolution of inbreeding are also discussed.

INTRODUCTION

The Iberian breed is the most important pig population of Mediterranean type. For centuries, this population was maintained with high census, without selection by any group of breeders, submitted to semi-arid continental climate in the woodlands of the S.W. of the Iberian peninsula. The breed conformation was developed through a process of adaptation to hard environmental conditions with poor housing facilities and extreme feeding levels according to seasons. Iberian pigs are characterised by early maturity, reduced appetite and metabolism, dark coat, long snout, small size and compact shape. The census was drastically reduced from 1960 to 1974, with the outbreak of African Swine Fever, the depreciation of the animal fat market and the massive introduction of foreign breeds in Spain (Dobao et al., 1988). In the last years, the production of pigs of Iberian type has experienced a rise associated with the establishment of a high price market for its cured products. Crossbreeding with Duroc is a very common practice, with strong dependence on a small number of elite herds supplying purebred Iberian animals and, in these conditions, the survival of some varieties is not out of danger.

The purpose of the present paper is to describe the conservation programmes of two important strains of Iberian pigs.

MATERIAL

The two strains, *Torbiscal* and *Guadyerbas*, are conserved at Oropesa (Toledo, Spain). Both groups come from an experimental herd of Iberian pigs settled there exactly 50 years ago. Since them full pedigrees have been recorded, with never entering new blood again. The herd was formed from four populations wich were representative of the different types of Iberian pigs in Portugal and Spain. They started with about 6 males and 20 females each. Every population was kept genetically isolated until 1963. Then, the four group were slowly blended, resulting in a composite strain named *Torbiscal* wich can certainly be considered as the main gene reservoir of Iberian swine. One of the founder populations, besides contributing to the building up of *Torbiscal*, was mantained as a separated closed line, owing to its striking features. These are the *Guadyerbas* pigs, which represent the ancient earliest maturing black hairless type.

METHODS

The theoretical aspects of the optimum form of conservation of a population with overlapping generations depend on the formula developed by Hill (1979) for the effective population size:

$$1/N_e = \left[2 + \sigma^2_{mm} + 2\sigma_{mm,mf}\, M/F + (M/F)^2\sigma^2_{mf}\right]/16ML + \left[2 + \sigma^2_{ff} + 2\sigma_{fm,ff}\, F/M + (F/M)^2\sigma^2_{fm}\right]/16FL$$

where M and F are the number of male and female parents born in each cohort, L is the mean of the generation intervals in the four pathways, σ^2_{mm} and σ^2_{mf} are the variances in the number of male and female progenies from male parents and $\sigma_{mm,mf}$ the correspondent covariance. For female parents the equivalent terms are σ^2_{ff}, σ^2_{fm} and $\sigma_{fm,ff}$. This formula is strictly valid only when the number of parents is large, the population has constant size and a stable age structure, the variation in family number is due to non-inherited causes and there is random mating over age-groups.

The population effective size is maximized when a balanced breeding structure is used because variance and covariance terms are equal to zero or minimized (Smith, 1976). This would occur if sires all leave the same number of sons and the same number of daughters ($\sigma^2_{mm} = \sigma^2_{mf} = \sigma_{mm,mf} = 0$) and dams all leave the same number of daughters and they have the same probability of leaving a son (M/F): $\sigma^2_{ff} = \sigma_{fm,ff} = 0$, $\sigma^2_{fm} = (1\text{-}M/F)M/F$. This criterion was introduced from the year 1982 in the choice of breeding animals in both strains.

Adequate mating plans can also contribute to minimize inbreeding. Minimum coancestry mating is the type of mating in which the average pairwise coancestry coefficient between sires and dams is minimum and corresponds to the mating system called by Wright (1921) maximum avoidance of inbreeding. The best combination can be found using linear programming techniques. If there are M sires and F dams, we can set up the matrix of coancestry [a_{ij}] among males and females and the problem there reduces to calculate the matrix of mating [x_{ij}] such that $\sum_i \sum_j x_{ij} f_{ij}$ is minimum, subject to the restrictions $x_{ij} = 0$ or 1, $\sum_i x_{ij} = 1$ and $\sum_j x_{ij} = F/M$. The advantages of this methodology have been previously discussed (Toro et al., 1988).

RESULTS AND DISCUSSION

Table 1. Analysis of cohorts in the *Torbiscal* strain: number of male (M) and female (F) parents, generation intervals (L), variances of family sizes (σ^2_{mk}, σ^2_{fk}), effective number per period of 2 years (N_{2y}) and proportion of maximum effective number with balanced family structure (N_{2y}/N_{2yMAX})

Period	M	F	L	σ^2_{mk}	σ^2_{fk}	N_{2y}	N_{2y}/N_{2yMAX}
64/65	26	92	2.0	23.5	1.6	53.8	0.42
66/67	20	88	1.9	19.1	2.6	35.6	0.40
68/69	30	77	2.2	63.8	4.2	24.2	0.14
70/71	22	61	2.5	74.8	11.5	21.0	0.13
72/73	32	130	2.0	40.8	2.8	35.5	0.23
74/75	35	110	2.4	44.3	3.2	55.6	0.23
76/77	38	134	3.1	65.1	3.7	83.9	0.19
78/79	19	110	2.6	21.2	2.0	74.8	0.47
80/81	33	158	2.8	25.0	0.9	132.0	0.40
82/83	38	111	2.7	4.4	0.6	280.7	0.85
84/85	6	16	2.4	3.6	0.7	33.4	0.82
86/87	11	50	2.8	5.0	0.7	84.5	0.77
88/89	14	41	2.4	3.9	0.7	72.1	0.78
90/91	11	38	2.2	3.3	0.8	44.5	0.67

In order to evaluate the changes in family structure along the history of both strains, cohorts of breeding animals born in succesive periods of two years were considered. The two-year effective size (N_{2y}) corresponds to the size of an idealized population with a generation interval of two years leading to the same increase of inbreeding observed in the current population in the same time. It is calculated according to the previously quoted expression of the effective population size per generation, because the relation between both parameters is $N_e\ L = 2\ N_{2y}$. In a similar way was calculated the maximum effective number per two-year periods corresponding to a balanced family structure (N_{2yMAX}).

Until the 80's, the conservation of genetic ressources of Iberian pig was not the main priority in the herd and therefore the rules corresponding to a conservation programme were not strictly applied and even a moderate empirical selection in favour of weaning weight was applied (Béjar et al., 1993). As the results of Tables 1 and 2 show, the variance of boar's family sizes ($\sigma^2_{mk} = \sigma^2_{mm} + \sigma^2_{mf} + 2\sigma_{mm,mf}$) indicates an unequal contribution of different lineages to the stud of breeding animals. On the other hand, the last two-year periods correspond to the introduction of conservation criteria to maximize effective size, although strict application was always subject to practical restrictions such as mortality or infertility of some individuals before the planned number of progeny had been obtained. It was specially frequent in the strain *Guadyerbas*.

Table 2. Analysis of cohorts in the *Guadyerbas* strain: number of male (M) and female (F) parents, generation intervals (L), variances of family sizes (σ^2_{mk}, σ^2_{fk}) effective number per period of 2 years (N_{2y}) and proportion of maximum effective number with balanced family structure (N_{2y}/N_{2yMAX})

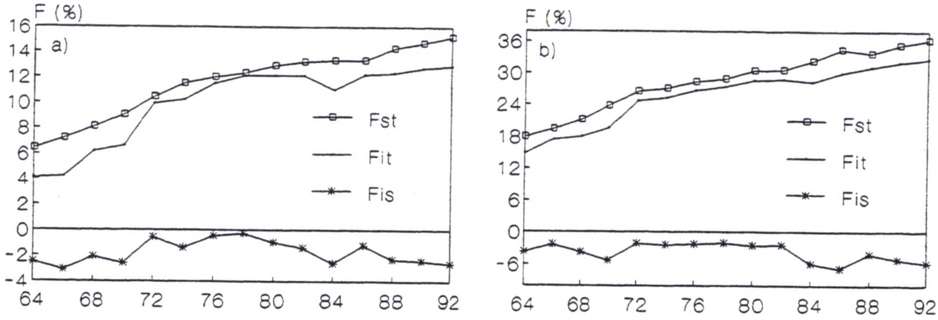
Period	M	F	L	σ^2_{mk}	σ^2_{fk}	N_{2y}	N_{2y}/N_{2yMAX}
64/65	15	40	1.6	13.2	1.0	21.7	0.45
66/67	10	34	2.3	56.2	5.2	11.8	0.18
68/69	11	28	2.5	10.1	13.1	16.2	0.21
70/71	9	18	2.0	71.6	3.5	4.5	0.11
72/73	25	76	2.0	34.7	3.1	24.5	0.21
74/75	14	38	2.6	9.3	1.1	66.4	0.61
76/77	10	28	2.7	50.9	2.1	20.5	0.24
78/79	4	18	3.1	6.9	7.5	12.0	0.26
80/81	8	29	2.8	28.9	1.8	22.0	0.29
82/83	8	30	2.7	27.3	2.8	22.2	0.31
84/85	6	14	2.4	4.3	2.7	18.2	0.44
86/87	4	17	3.2	5.7	2.1	31.5	0.61
88/89	7	12	3.0	11.9	4.0	21.1	0.31
90/91	6	15	2.0	6.3	0.8	20.0	0.68

The harmonic mean of the two-year effective size for all the studied periods was 47.00 (*Torbiscal*) and 16.82 (*Guadyerbas*) implying annual rates of inbreeding of 0.0053 and 0.0149, respectively.

In order to analyze the effect of mating strategy, the Wright (1951) statistics F_{IT}, F_{IS} and F_{ST} were calculated. F_{IT} is the average inbreeding of the breeding individuals born in a cohort of two years, F_{ST} is the average coancestry coefficient among all their sires and dams. Both were calculated from the pedigree files. The third statistic, F_{IS} is calculated from $(1 - F_{IT}) = (1 - F_{IS})(1 - F_{ST})$ and it express the lack of randomness in the actual matings.

The values of F_{IS} are always negative reflecting the three different tactics used to avoiding mating among relatives. Until the year 1972, matings were planned considering the coancestry coefficients among the breeding animals, although without a formal solution to the minimization of increase of inbreeding. From 1973 to 1981 the coancestry coefficients were not available previously to the mating design, that only avoided mates between animals with common grand-parents. From 1982 the calculus of the best mating combination is solved by linear programming techniques.

Fig 1. Evolution of coancestry (F_{ST}) and inbreeding (F_{IT}) in the strains a) *Torbiscal* and b) *Guadyerbas*



The mean values of the coancestry (F_{ST}) and inbreeding (F_{IT}) coefficients at the last analyzed period (1992/93) were 0.152 and 0.129 in *Torbiscal* and 0.364 and 0.327 in *Guadyerbas*. Additional evidence that confirms the interest of minimum coancestry matings in this type of situations come from the comparison between these values and the expected inbreeding values calculated from the two-year effective size number under the hypothesis of random mating. These values were, for the last period, 0.199 in *Torbiscal* and 0.549 in *Guadyerbas*.

In the framework of animal production, the conservation of these strains has always been combined with their diffusion to the farmers. *Torbiscal* is very appreciated by producers for crosses with other strains of Iberian pigs. *Guadyerbas* has been traditionally rejected by the farmers because of his poor growth and extremely fat carcasses. However, as a good example of the practical importance of conservation activities, this strain is now largely demanded for crosses with Duroc to improve the meat quality of final products.

REFERENCES

BEJAR, F., RODRIGUEZ, M.C. and TORO, M.A. (1993) Livestock Production Science, **33**: 239-251.

DOBAO, M.T., RODRIGAÑEZ, J., SILIO, L. and TORO, M.A. (1988) Pig News and Information, **9**: 277-282.

HILL, W. (1979) Genetics, **92**: 317-322.

SMITH, C. (1976) Animal Production, **23**: 403-412.

TORO, M.A., NIETO, B. and SALGADO, C. (1988). Livestock Production Science, **20**: 317-323.

WRIGHT, S. (1921) Genetics, **6**: 111-178.

WRIGHT, S. (1951) Annals of Eugenics, **15**: 323-354.